cable;

Fig. 14 is a vertical sectional view showing another modification of the measuring probe; and

Fig. 15 is a vertical sectional view showing another modification of the measuring probe.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention will be explained in detail below with reference to the drawings.

Fig. 1 is a block diagram showing a plasma processing system capable of carrying out one example of a plasma density information measuring method of the invention comprising one example of a plasma density information measuring probe and one example of a measuring apparatus of the invention. Fig. 2 is a vertical sectional view showing one example of structure of the plasma density information measuring probe (which will be omitted as "measuring probe" hereinafter) according to the invention. Fig. 3 is a transverse sectional view showing a structure of one example of the measuring probe of the invention.

As shown in Fig. 1, the plasma processing system of the embodiment comprises a cylindrical stainless steel chamber 1 of about 10 cm diameter having a space S in which reactive plasma (which will be omitted as "plasma" hereinafter) PM is generated, an ignition electrode (ignition antenna) 2 disposed in the chamber 1 for generating plasma, a vacuum discharge pump 4 which is in communication with the space S of the chamber 1 through a discharge pipe 3, and a gas source 7 which is in communication with the space S of the chamber 1 through a gas supply pipe 6 provided therein with a flow rate adjusting valve 5. In addition, a board (not shown) of a work

(object to be processed) W, and a transfer-in/transfer-out mechanism of the work W are also disposed in the chamber 1 of the system of the present embodiment.

Air in the space S of the chamber 1 is exhausted by the vacuum discharge pump 4 and the space S is kept at appropriate pressure. Atmospheric pressure in the space S when plasma PM is generated is in a range from some mTorr to some tens mTorr for example. Gas is supplied from the gas source 7 at appropriate flow rate. Examples of the gas to be supplied are argon, nitrogen, oxygen gas, fluorine gas, and chlorine gas. The gas flow rate set by the flow rate adjusting valve 5 is in a range from 10 to 100 cc/minute for example.

A high-frequency electric source 8 for supplying high-frequency power (high-frequency electric power) for generating plasma is provided outside the chamber 1. The high-frequency power output from the high-frequency electric source 8 is sent to the ignition electrode 2 through an impedance matching device 9. The magnitude of the high-frequency power output from the high-frequency electric source 8 is in a range from about 1 to about 3 kW for example. The frequency of the high-frequency power should not be limited to particular frequency, but the frequency of the high-frequency power is usually in a range from RF band which is typically 13.56 MHz to a microwave band of about 900 MHz to 2.45 GHz.

In the case of plasma of inductively coupled RF discharge plasma, an induction coil is used as the ignition electrode 2, and in the case of capacitive coupled RF discharge plasma, a flat electrode is used as the ignition electrode 2. Further, in the case of microwave discharge plasma in which frequency of high-frequency power is frequency of microwave band, a horn antenna, a slot antenna or an opened waveguide is used as the ignition electrode 2.

When frequency of high-frequency power is RF band frequency, a matching

circuit in which inductance and capacitance are combined is used as the impedance matching device 9. When frequency of high-frequency power is microwave band frequency, an EH tuner or a stub tuner is used as the impedance matching device 9.

In the case of the system of the present embodiment, there is provided a reflection power monitor 10 which detects a reflection amount of high-frequency power returning to the electric source side without being absorbed by plasma load, and which sends the detected reflection amount of the high-frequency power to the power adjusting section 11. The power adjusting section 11 controls the impedance matching device 9 such that the reflection amount (reflection electric power amount) of high-frequency power becomes minimum, and stabilizes the plasma density.

The work W is subjected to etching process or the CVD (chemical-vapor deposition) by plasma PM generated in this manner. The system of the embodiment is provided with an apparatus for measuring information concerning the plasma density which excellently shows the characteristics of the plasma PM. In order to subject the work W to appropriate processing, it is very important to measure the plasma density information to grasp the characteristics of the plasma PM.

As shown in Fig. 1, the plasma density information measuring apparatus of the embodiment comprises a measuring probe 12 mounted to a wall of the chamber 1, and a probe control section 13 disposed outside the chamber 1. A specific structure of the measuring probe 12 will be explained first.

As shown in Figs. 2 and 3, the measuring probe 12 comprises a dielectric tube 14 whose tip end is closed and rear end is opened into atmosphere (outside air), a loop antenna 15 for radiating high-frequency power, a coaxial cable 16 connected to the loop antenna 15 for transmitting the high-frequency power to the loop antenna 15, and an aluminum conductor piece 17 for preventing leakage of radiated electromagnetic wave.